GYMNASIUM.

THE AGRICULTURAL STUDENT.

VOL. VII. OHIO STATE UNIVERSITY, COLUMBUS, SEPTEMBER, 1900. No. 1.

TERMS OF SUBSCRIPTION:

One Year.............................. $0.50
One-half Year.......................... .30
Single Copies.......................... .05

While this magazine is published with the approval of the President of the University and the Officers of the College of Agriculture and Domestic Science, the editors are responsible for the statements in all unsigned articles.

Address all communications to the Business Manager, Agricultural Student, Columbus, Ohio.

Entered at the Post-Office, Columbus, Ohio, as second-class matter.

PUBLISHED MONTHLY BY

THE AGRICULTURAL STUDENT PUBLISHING COMPANY.

VERNON H. DAVIS.......................................Editor
W. D. GIBBS.......................................Business Manager

STAFF.

C. B. STEWART. E. O. FIPPIN.
C W. EDDY. F. W. TAYLOR.
C. N. MOONEY. MISS MAMIE F. HILL.

EDITORIAL CHAT.

With this issue the managers of the AGRICULTURAL STUDENT begins another year's work. We hope that this, the seventh volume will carry some evidence of improvement, as we feel the former ones have done. Those in charge of the work will do all in their power to make the STUDENT a magazine worthy of the Department and students, but to make it such, they must have the support of every student in the college. Every student should feel that they have an interest in the magazine and that it is his duty to subscribe for it, and his privilege to contribute something from his own observation to its columns. Remember that the magazine is published by and for the benefit of the entire student body in the Agricultural Department.

Each member of the staff will as far as possible have charge of some special line of work and will report anything of interest therein. The STUDENT will endeavor to publish from time to time, the result of such scientific research and original investigation as may be carried on in the University, especially in the College of Agriculture and Domestic Science.

We wish to ask all friends of agricultural education for their co-operation during the coming year, especially do we request all ex-students and alumni to report anything of scientific interest, that we may use it in our columns. Any suggestions from our readers at any time will be gratefully received and considered and we trust that we shall merit a continuance of the good fellowship so generously given us in the past.

The STUDENT takes this first opportunity to welcome the new students among us. At the beginning of each year the freshman class is the center of attraction, for it is indicative of what the University is to be. It must be taken for granted that each student desires to get as much as possible out of his college course. To do this there are several things you must decide for yourself. The primary object of every student is, or should be, thoroughness in his or her class work, but there will be some time for other things—things which will go a great way in determining how much or how little you get out of your college course.

In the first place every student should become a member of some literary society, for it it here more than in any other place that the power of expression is acquired. Many students have testified to the fact that the work done in their literary societies was equivalent

to one year in college. You cannot afford to miss it. Again, taken an interest in all University affairs. They are yours as much as any one's, and reflect credit or dishonor on you as well as the entire University. If you have ability in athletics, debating, oratory or any other line, enter actively into the work If not, encourage, bv your presence, whenever possible. Attend your class meetings; vote and vote intelligently at all times you have the right to do so—in short, don't be a parasite and take everything and give nothing. Contribute your mite, however small, as a good citizen, to the college life of which you will be a part for the coming four years.

The following statistics are taken from the address of Dr. Butler before the National Educational Association: "The annual expenditure of the United States for her common schools is more than the sum-total of the expenditure of Great Britain and Germany upon their powerful navies. The sum has more than trebled since 1870, and has increased from $1.70 to $2.07 per capita, and from $15.20 to $18.86 for each pupil enrolled."

With increased greatness this country realizes that its only safety is in its great free system of education. The United States depends more upon the quiet voice of the school master to carry knowledge and civilization abroad, and prevent anarchy and rebellion at home, than upon powerful armies and navies.

Townshend Literary Society is one of the four distinctly literary societies for men in the University, and stands second to none in the quality of its work. While Townshend Society receives as members students from any department, it has always been pre-eminently the Society of the Agricultural Department. The Society meets every Friday evening in its beautiful room in Townshend Hall, and extends a cordial welcome to everyone, but at this time of the year, especially to the new students. There is no better place to spend at least one evening a week, and you will be sure that you have begun your college course right.

On account of enforced absence at the beginning of school the editor is unable to announce the staff for the coming year. The same will be announced in the next issue.

The writer stood, one hot July day of the past summer, on the shore of Lake Erie some ten miles west of Sandusky, and watched a farmer harvesting his oats. The oats were on "lake front" land (worth, I was told, from $500 to $1,000 per acre), and in spite of the fact that they had evidently been sown, plowed under and left with little, if any, harrowing, there was a medium crop of straight standing oats. The farmer (?) was cutting the crop with the mowing machine while his wife followed after, with a hand rake, raking the mown oats into piles the size of ordinary sheaves, after which they were bound by hand. It is safe to say that this man would be loud in his derision of "book farmin'." Educate the farmer that he may not disgrace the soil.

The Ohio Dairy School.

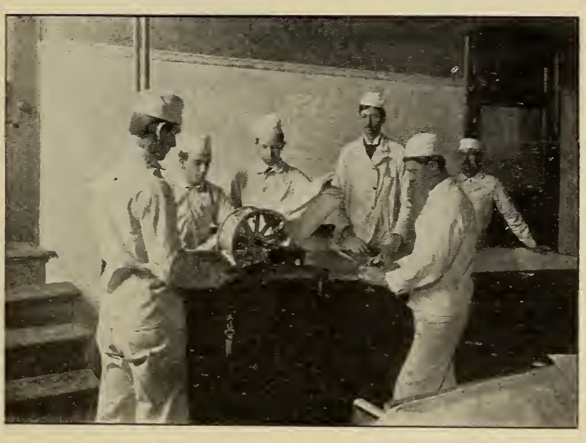
The farmers of Ohio have every reason to be proud of the fact that the Dairy School at the Ohio State University is leading the dairy schools of the country. Word has lately been received by Professor John W. Decker, who is in charge of the school, that the cheese made by pupils of the Dairy School last winter, and exhibited by him at the Paris Exposition has been awarded a gold medal over all competitors in its class.

The cheese that has taken this award was cheddar, American brick and edam, made entirely by students as required work, and the thoroughness of

the instruction is evidenced by the above results.

Professor Decker, who has charge of the school, was called to the University last fall. For ten years previous he was an instructor in the Wisconsin Dairy School, winning a diploma at the Chicago Exposition in 1893 for cheese exhibited there. He was a student and co-worker of Dr. S. M. Babcock, inventor of the Babcock Milk Test. He has turned out more dairy students than any other teacher in the country, about 1,000 having passed under his instruction in the past ten years. Under his direction the local school is making great strides. Already there are as many applicants for admission next January as there were in attendance last winter.

Other schools had cheese on exhibition at Paris, but it is not known yet what they may have been awarded. This, however, is sure, Ohio received the gold medal, and if any other school receives one it comes in another exhibit from which Ohio is ruled out.



MILLING THE CURD.

PRESSING THE CHEESE.

Corn Harvesting.

The thought comes to me as each corn cutting time approaches, what an enormous task the farms of this country have on hands to harvest the entire corn crop of the Nation. Any attempt at the introduction of machinery for the scientific harvesting of corn has been made only in the last few years, and has been brought about through efforts to save the stover, formerly, and in many localities at present so wantonly wasted.

The first implement used for cutting corn was the hand cutter either crooked or straight, with which we are all familiar to-day. The sled cutters marked the first advance, and these have proved a great labor saving, where all the conditions are favorable. However, they have not, and never can solve the problem in hand. Within the last few years two machines have appeared which are destined to revolutionize the harvesting of corn, and result in a saving of millions of dollars to American farmers. They are the corn harvester and husker. The harvester is a modified form of the binder, so successful in the harvesting of wheat. While there are many improvements necessary before the machine is perfect, the rapid increase in its use leaves no doubt but that in a few more years the bulk of the corn crop will be cut by the harvester.

Many difficulties are to be overcome in the harvesting of corn by machinery. The large size and also the great variation in size of the plant makes strong and heavy machinery necessary. But if properly cultivated the ground will be soft, which combines with the weight of the machine to make the draft heavy and the expense of operating great. The attachment of the ears to the stalk make the plant difficult to handle without knocking off a great many of them, and at the same time very hard to make a bundle that will retain its shape while handling. However, thousands of farmers all over the country consider these difficulties sufficiently overcome to make the harvester a practical success with them and they are loud in its praise. The original cost of a harvester will probably prohibit the small grower from using it, but the question is becoming more and more one of economical farm management rather than any difference of opinion as to its merit. The harvester binds the whole plant into bundles, which are usually placed in shocks until sufficiently dry to husk. The bundles cure well when properly shocked and the work of handling is made much easier. The habit of feeding the whole fodder to cattle is growing in favor and when fed thus there is a great saving of space when stored, and much labor saved in handling. We have become so accustomed to growing this plant for the grain it yields, and using the roughage as a sort of straw to be eaten or wasted as accident determines, that we have almost wholly overlooked the feeding qualities of the latter.

Experiments have determined that the stover of the corn crop seems to reach the highest yield and the best condition for feeding at a stage of growth indicated by a well-dented kernel and the first drying of the blades. The grain reaches the highest yield and the best condition for utility, at a stage of growth indicated by a well-ripened ear and a half-dried blade. The best time for securing the crop with reference to the highest utility of both is found at a stage of ripening between the above.

When harvested in the usual way, leaving the fodder in the field until ready to use, there is a very heavy loss amounting to nearly one-fourth of the dry matter and protein in the stover.

The portions lost are the most valuable part of the forage. In comparing the yield of corn and stover, and the amount of digestable matter in each, from one acre of land, an average of the results at the New Jersey, Connecticut, Wisconsin and Pennsylvania Stations give 53.6 per cent. of the total crop in the corn and 46.4 per cent. in the stover; 63 per cent. of the digestible nutriments was in the corn and 37 per cent. in the stover. Corn stover contains a large amount of digestible carbohydrates but is deficient in protein. Its chief value therefore is as a cheap source of carbohydrates, and when supplimented by some feed rich in protein, it can hardly be surpassed in the cheap production of material growth, beef and milk. The average of numerous feeding experiments give the total amount of digestible nutriments in corn stover, timothy hay and clover hay to be respectively 36.6, 49.4 and 43.2 per cent. of the total weight. The number and extent of these trials are too numerous to leave any doubt as to the value of corn stover, in great part wasted in the past.

While the invention of machinery for cutting corn has been slow the inventions of husking machinery has been even slower. The human hand with various appliances has been the only means of husking corn since its cultivation was first begun, until within the last few years. A little over a decade ago the first husker was put into practical use. The machine husked the corn and cut the fodder at the same time. There is yet some doubt with many whether there is any actual saving of expense over husking in the old way when the grain alone is considered, but the increased value of the stover when shredded as the husker of today leaves it, will make this machine within a few years as common as the thresher.

The waste of the stover in the past may be accounted for in part by the fact that there was no practical way to change the coarse stalks into a form in which it could be readily eaten by stock, and conveniently handled by the feeders. The first huskers were equipped with a cutting head, but in the last few years cut stover has been rapidly replaced by a shredded product.

Shredding leaves no sharp edges and the hard outer shell of the stalk is so shredded and broken that even the lower portion of the stalk is readily eaten. Professor Henry, of Wisconsin, found that here was a saving of 24 per cent. in feeding milk cows stover in the shredded form.

The shredding of the stover has developed a new industry which in a few years will be a valuable source of income to the farmers of America. Bailed shredded fodder is fast becoming an article of commerce and may be seen in any feed store in the cities. When good timothy hay is selling for $8 per ton bailed shredded fodder sells for about $6 per ton. A feed dealer in this city said to me that this product was fast becoming the chief rough feed bought. He suggested to those bailing it that three wires be used instead of two, as with two only, it gave some trouble in handling by coming apart. To the question whether stover thus treated will keep, the large amount of bright shredded fodder on the market is a sufficient answer. There are certain conditions that must be followed but which must be determined for each locality. Like hay, the stover goes through a sweat, but this does not harm it if left alone. It will be several years before the average farmer learns how to manage this new material for the best results, but its excellence and cheapness when properly cured, will, in the near future, make it as much a staple article of feed as hay now is.

In the central and eastern portion of the country the stover, when shredded, is usually run into mows or sheds. In this form it takes up much less room than the whole stalks. In the west the shredded stover is stacked like hay, and when the work is properly done it keeps equally as well. When bailed it must have previously gone through the sweating process to prevent moulding.

This new "corn fodder hay" has an additional value as an absorbent for bedding far superior to straw. The soft pith of the corn stalk is unquestionably the best bedding yet discovered for the absorption of liquid manure.

Corn leads all other cereals in the number of bushels produced in this country. But when the value of the stover becomes more generally understood and the machinery for harvesting the crop is placed on the same level of perfection as the implements for preparing and cultivating the soil, the production will vastly increase, and corn will be indeed king.

The Farm Door Yard.

In traveling through the farming districts of the State one cannot help noticing the great need of improvement in the majority of farm lawns. Occasionally there appears in farm papers an article on this subject, but they are sometimes the expression of admiration for pleasant surroundings without giving any particular directions toward improvement.

The first essential is a good smooth turf on the lawn, which may be had in a short time by sodding. If the area is too large to be sodded cover it thick with well rotted manure, spade it under, get the surface in good condition for the seed and sow thick with a mixture of white clover, bluegrass and red top. A lawn mower is necessary to keep a lawn in good condition. Its use tends also to exterminate weeds which are largely annuals or biennials and will disappear if kept from seeding by frequent cutting. In order to give the grass renewed vigor in the spring it is a good plan to cover the lawn with a thin layer of fine and well rotted manure. This should be done in the autumn and raked off in the spring.

When the lawn is being made the walks and drives should be laid out. In a large lawn don't make them straight. In a modern park you never see a straight driveway partly on account of the tendency of vehicles to form ruts as the hind wheels follow directly in the track of the front wheels. In curved drives this is not the case nor do two vehicles follow the same track. Curve the driveways around among the trees and shrubs and you get a much better effect than with straight ones. They are too mechanical. The modern idea is to imitate nature. Plant a clump of trees and shrubs and cruve the driveway around the clump as if to avoid it.

Next comes the planting, which is by far the most important of the work. Select good thrifty varieties of shrubs and trees and plant plenty of them. Directly in front of the house it is not best to have anything but clear lawn unless it be a flower bed. This, however, is a matter of taste. At the sides and in the rear may be planted a few specimens of the larger trees as elm, maple and evergreens intermingled with some flowering trees such as the catalpa and horse chestnut. The trees should be irregularly placed, never in rows. Also plant here and there a cut-leaved weeping birch which is a very pretty drooping tree. The magnolia is a good tree for early blooming. In selecting shrubs try to get those least subject to disease. I would not advise planting

many roses in the lawn. Unless they are sprayed with some poison solution they will be ruined by insects. The following list will prove very satisfactory and inexpensive: Althea. Flowers from summer to autumn. Forsuthia. Early spring, flowering. Lilac. Deutzia. Flowers in June. Best in clumps. Snow Ball. The Japanese variety is free from fungus disease which destroys the common variety. Spirea van Houttei. A very beautiful and graceful white flowering shrub. Privet, Weigelia and Almonds are also very good shrubs of the smaller class. The Hybiscus is a good shrub for August blooming if kept well cut back. It is best to keep the ground free from grass and weeds where shrubs are planted and give it a thorough hoeing several times during the season. Cut out dead wood in the spring and if any pruning of live wood is necessary do it in the fall after flowering time. Do not fail to get some climbing vines for the veranda and other parts of the house and grounds. The clematis Jackmanii is a very good vine for the veranda, having large purple blossoms in great profusion. Clematis paniculata is a very pretty vine having white and very fragrant flowers. Ampelopsis Veitchii is a flowerless vine used to cover exposed and bald looking parts of the house. It will support itself.

These plants are not expensive, and will add much to the appearance of a home. The whole list mentioned should not cost over $10 if one of each is purchased. The forest trees may perhaps be got on your own farm. There are usually many fine growing specimens growing in the woods or fence corners. If you have none ask your neighbor for them and thus spread the desire for improvement. If all the work cannot be done at once, do it little by little and you will soon have a beautiful home admired by everybody.—J. C. Britton in *Ohio Farmer*.

The Evolution and Comparison of Reaping Machines.

ABSTRACT OF THESIS, BY M. F. MILLER, JUNE, 1900.

This work was undertaken with the object of ascertaining, as nearly as possible, the true development of reaping machines and of determining in a measure to whom credit is due among the long list of inventors who have joined in evolving the machine of today.

The treatise is divided into four chapters, the first three of which take up the subject historically, tracing the development of the machine from the earliest hand implements down to the perfect machine of to-day, while the last includes a detailed comparison of the five machines found in the University Agricultural Museum; the Deering, Osborn, Milwaukee, Champion and McCormick.

Anything like a complete historical treatise of this subject includes a great amount of material so that in a short review of the work, only the more important inventors and inventions can be noted.

The process of reaping is older than written history. The first implements which are supposed to have been used for this purpose are found among the works of prehistoric men, such as those of the later stone period of Great Britain. The first forms were of stone, but later bronze, and finally iron came into use for fashioning rude sickles resembling somewhat those of the present day. The ancient Egyptians did much towards developing this implement which with little change has come down to the present time. The scythe developed along with the sickle after they were once introduced which, however, was at a later period than the latter. The sickle, however, remained pre-eminent as a reaping implement for centuries, or until the American grain cradle came

into use, which was towards the latter part of the eighteenth century. It is true, however, that an attempt had been made to construct a machine driven by animal power long before this time. Pliny, about A. D. 23, mentions a machine as in use in the fields of Gaul, which was pushed by an ox and which consisted of a box mounted on wheels and bearing a row of sharp teeth on its forward edge which stripped off the heads and allowed them to be raked into the box by an attendant. This seems to have been used to some extent at that time, but was of little consequence and was eventually forgotten.

English inventors were the first of modern men to turn their attention towards constructing a reaping machine, and many attempts were made along this line, some of which gained considerable notoriety at the time, and which were really valuable inventions.

A man by the name of Cable Sloft was the first of these to suggest a reaping machine. It was after the plan of the Gaulic reaper but was never constructed in a practical form. Other inventors tried the principal of a revolving cutter, and several machines were constructed after this plan. None were practical however although the revolving principle was still tried for years after the vibrating cutter came into use. The most important of English machines or at least the one which excited the most comment, was that of Patrick Bell, in the year 1828. This machine had several pairs of shears arranged side by side for cutting the grain and a canvas roller for depositing it in a swath at the side. It was used with slight success for several years and was also introduced into America. A few years before this, however, in 1814, a machine was constructed by Henry Ogle which, although it never became so prominent as Bell's, yet contained several principles which were vital to the modern reaper. It had a straight edged knife vibrating over iron teeth, a reel resembling the modern one, and a platform to receive the cut grain. It never came into prominence owing to labor disturbance at that time.

Many other inventors brought out machines and through the aid of American inventors, who now took up the work, reaping machines of different styles became quite common in England and on the Continent.

The first attempts in America were mostly along the line of grass cutters, but in the earlier machines they were so closely related to grain cutters that they may be discussed together. Several machines of minor importance were constructed before the celebrated one by Obed Hussey which was patented December 31, 1833. The next year, June 21, Cyrus McCormick patented his celebrated machine. These two machines were the basis upon which all successful machines were thereafter built, and the controversy between these two men for priority of invention and originality of successful principles was one of the most celebrated on record. Hussey's machine consisted of a frame mounted on two wheels, with a side bar cutter consisting of triangular plates riveted to a bar, the whole reciprocating through slotted teeth or guards. This was used both as a grass and grain cutter, but the principle was more after the style of the modern mower than of a grain cutter. McCormick's machine had a reciprocating knife with a sickle edge, vibrating through projecting wires to hold the grain while being cut, a platform from which the grain was raked and a reel to hold the grain against the knife. Both men improved their machines afterwards and secured later patents, but to say that either man was the inventor of the reap-

ing machine would be far from the truth. Both made valuable machines, and each had some original principles, but the greater part of each machine had been foreshadowed by other inventors. Both men, however, did splendid work, and to them should be given most credit in bringing about the development of the reaping machine.

The foundation now laid, other inventors began helping to improve these crude forms, and from them was developed the reaper or selfrake, the mower, and finally the modern binder. Among the inventors who brought out valuable improvements on the selfrake might be mentioned: Nelson Platt, who patented a selfacting rake sweeping over a quadrantal platform; Palmer & Williams with a rake which swept the platform at regular intervals, and Hoffheim, whose device afterward improved by Dorsey, Johnson and others became the modern selfrake. This form of machine had not long to remain king however, for the automatic binder soon came into use, thus replacing the selfrake.

The first automatic binders were placed upon different forms of the selfrake, but were never successful as thus applied. In 1858 the Marsh Brothers of Illinois, patented their celebrated harvester, resembling in form the binder of today, but carrying men to do the binding. It was to this type of machine that the binder was successfully appled, through the efforst of Locks, Gordon, Appleby and others. By 1880 the modern binder was practically perfected and together with the large headers and combined harvesters and threshers of the west it stands as the modern type of reaping machine.

The last chapter of the thesis is devoted to a detailed comparison of the 1900 models of the Deering, Osborn, Milwaukee, Champion and McCormick binders. No attempt is made to favor any one machine, but the similarities and differences are noted, and the comparison carried out as far as possible.

The text of the thesis is supplemented by about thirty cuts and drawings.

The Agricultural Engineer.

By WM. T. MAGRUDER.

The history of technical education in this country is the history of development by specialization and by differentiation. In the present century our engineering colleges are but repeating the same "process of natural differentiation by which the more modern faculties of the European university arose out of the primitive university."

Up to the beginning of this century all engineers were self-taught. The first two students to be granted the distinction of being called engineer were graduated in 1802 from the Military Academy at West Point. In the next twenty-five years, out of the 500 men who were graduated there, 57 were civil engineers. In 1828 the Institution of Civil Engineers of Great Britain received its charter. In 1840 the Rensselaer Polytechnic Institute graduated 13 civil engineers, who were the first college graduates in civil engineering in any English-speaking country. The schools of engineering of Union, Harvard, Yale and Michigan followed within the next twleve years. In 1863 the Columbia School of Mines was founded. It was the first school in this country which recognized mining as an applied science and mining engineering as a course of study leading to a degree. In 1861 the Massachusetts Institute of Technology was incorporated and in 1868 graduated its first class, which consisted of 5 civil engineers, 1 mechanical engineer, 6 mining engineers, and 1 graduate in science.

In 1868 the first degrees in mechanical engineering were conferred; 5 by the Rensselaer Polytechnic Institute, 1 by Yale, and 1 by the Massachusetts Institute. An electrical engineering course was started at Stevens Institute in 1880 and at Cornell in 1885, along with a course in marine engineering. The course in chemical engineering as first laid out by the Massachusetts Institute of Technology is the latest differentiation—itself a specialized course in mechanical engineering.

The mighty forces are still at work which brought about this differentiation; first from military engineering, then from civil engineering, and then from mechanical engineering. They are still potential and active, and are but following the law of supply and demand. With the demand for quicker transportation by sea and by land came the canal and the railroad, and with them came the civil engineer. With the greater demand for fuels, especially for metallurgical purposes, and for the more costly metals came hoisting and pumping engines, the smelter and the converter, and with them came the mining and metallurgical engineer. When it became necessary and possible to replace the hand pumps and horse powers of our grandfathers with the triple-expansion high-duty pumping engine and the Corliss or Willans engine of today, the mechanical engineer was needed to design, construct and operate such complicated machinery. Similarly with the dynamo and electric motor came the electrical engineer, or mechanical engineer, whose specialty was electricity; and with the vacuum pan, gas retort and pulp mill came the chemical engineer.

Since the passage of the land-grant bill of 1862 and the Morrill act of 1890, coupled with the immense tide of immigration to this country, gigantic strides have been made in the realm of agricultural science and development, and with this development has come the great and still growing demand for agricultural machinery, tools and conveniences.

When the implements of the average farm consisted of a few hand tools, comparatively little general skill was required in their use, care and repair; for their manufacture but few special appliances were required, and ordinary commercial manufacturing ability sufficed to keep the price down so as to reap a goodly profit. With the introduction of the more complicated forms of farm machinery, as seen in the mower, reaper, harvester and separator, and with the keener competition between the manufacturers of rival machines, the best of engineering skill and ability has been sought and employed in the manufacture and the testing of these machines. That the price of agricultural machinery has been reduced so much in the past few years is the triumph of the mechanical engineer, whose specialty is agricultural machinery.

The popular impression is that agricultural machinery is made in the foundry and put together by boys in the snag shop, and that it is anything but accurately fitted. On the contrary, there is but little machinery manufactured on which the limits are closer. It is doubtful if even watchmaking machinery is any more accurate in proportion. A few cases will illustrate the point in detail. In the manufacture of a mowing machine the greatest allowable variation from exactness is the one-hundredth of an inch in the 30 inches between two holes in the mower shaft, and even this is considered a large allowable variation. On a brass bush for the same the limit is five one-thousandths of an inch on the inside running fit and one

one-thousandth of an inch on the outside driving it. In a certain agricultural machinery works a machinist in the tool room was told to make a 13 1-3 inch length gauge out of a bar of 5-8 inch square steel. A 24-inch steel scale and a magnifying glass were his only instruments of measurement. Later, this bar was measured on a Pratt & Whitney comparator and found to be 13.334 inches, or two-thirds of one one-thousandth long. In the testing of new agricultural machinery, it is not unusual to send a competent mechanic with the machine into the field, with instructions to test it as severely as possible, so as to discover to the manufacturer its defects before other machines are generally put on the market; and to this end a score of machines may be put into the hands of farmers in different portions of the country for thorough and practical test. For these positions are, therefore, required men who understand the practical difficulties of the field and farm and can apply the knowledge so gained in rectifying the difficulties so discovered.

On many of the farms of the West and South will be found collections of machinery and agricultural implements aggregating thousands of dollars. In order that the same should have a chance to wear out and not rust out, they should be kept up to their maximum point of efficiency. The day has long since passed when an ignorant farm hand at $15 to $30 a month is required or allowed to take charge of and keep in repair the $500 to $5,000 worth of machinery which can now be found on many of our farms. On the largest farms and plantations several competent men are required during the seasons of use to be continually fixing and repairing these machines and keeping them in the best condition. Between seasons, these same men act as handy men in other lines of mechanical industry, provided they do not migrate. Even on our smaller farms, a mechanic with judgment and experience can find many places where his mechanical knowledge and skill can be economically applied. And what is true of the farm and plantation is equally true of the dairy and creamery. In the above avocations, a skillful agricultural machinist is required; and if he has had the education afforded by our agricultural and mechanical colleges, he is just that much better off in personal equipment and is of greater value to his employer.

But as from the surveyor, the miner, the mechanic, the electrician have been evolved the civil, the mining, the mecahnical and electrical engineer, respectively, so from the agricultural machinist, and to superintend the manufacture of agricultural implements and machinery, has been evolved the agricultural engineer.

Let us now consider what his training should be for the positions which he is competent to fill. From what has already been said, it is evident that the agricultural engineer is a skilled mechanic who by natural genius, by acquired skill and judgment, and by much study either in the school of experience or in one of our technical schools, has risen above the ranks and has become a leader, and is competent to design, construct and manufacture new machinery and appliances which shall successfully fill the needs of the agriculturist. In a word, he is a mechanical engineer whose specialty is agriculture, and belongs to the same class or family as do the electrical, locomotive, or marine engineer, and should be the special subject of consideration of our agricultural and mechanical colleges. He should receive not

only a most thorough grounding in the underlying principles of engineering sciences, but should in his senior and post-graduate years take such work in agriculture as will enable him to understand and to appreciate the problems of the agriculturist. He should be given a much more thorough course in shop work and in drawing than is given to the average agricultural student, because he must be something more than simply "handy with tools;" he must be as nearly a journeyman mechanic as it is possible for the schools to make him, and he must understand the principles underlying all shop manipulations and processes. As manufacturing may be his end, economics, labor problems, cost accounts, as well as problems in the mechanics of manufacture, should be carefully studied. Under mechanism should be included the study not only of those mechanisms now found on agricultural machinery, but the principles which will enable him to design new and adapt old mechanisms to new ends. Under the dynamics of machinery should be included not only the subject of animal mechanics and the draft of vehicles, plows, etc., but the dynamics of transmission machinery.

Now that steam boilers and steam and gasoline engines are so generally used in the field, on the road, and in the factory, it is desirable that the man who is to superintend them should have more than a superficial knowledge of them and of their construction and needs. The fellow who simply does not let the boiler explode and has sense enough to send to town for a mechanic when he thinks that his boiler may need some tinkering, possibly earns all the wages that he gets; but the man who by stopping all leaks by keeping the inside of his boiler clean, and by careful and thoughtful firing evaporates more water per pound of coal, frequently saves to his employer more money than he receives.

With the introduction of machinery into the dairy, the creamery and the cheese factory, the old vine-covered spring house has put off its traditional rural ways, machinery has taken the place of human hands, and the evil-smelling ammonia has displaced the cooling, trickling stream of spring water, and the trained and scientific agriculturist has superseded the milkmaid of song and fable. Here, then we have need for the engineer who has a wide training and experience in chemistry and in physics.

Now that the demand is arising for competent men to invent, construct, care for and operate our farm machinery, does it not become the duty of at least our agricultural and mechanical colleges to pay special attention and give more time than at present to the principles underlying this rapidly growing specialty; and is not the time near at hand when all agricultural students shall receive instruction in the mechanics of machinery, and in the practical care and construction of agricultural and creamery machinery from the mower to the ammonia refrigeration plant? Such, it would seem to the writer, is the field of labor and of enterprise of the agricultural engineer.

The Evolution of the Plow.

ABSTRACT OF THESIS, BY F. W. TAYLOR, 1900.

The plow has from time to time been so much improved that it may now be accepted as the most perfect that we have for preparing the soil for a crop; no other can compete with it in regard to the amount and quality of the work performed, taking into consideration the time and expenditure of power. The

superiority of the present day plow over the primitive plow of centuries ago cannot be questioned—simply a glance at the two shows that there has been a wonderful evolution, both in form and utility.

In briefly summarizing the history of the plow, let it be noticed that the first plow-like implement was a straight stick sharpened at one end; after this came the pick-ax or hoe; then the forked stick with a handle attached, drawn by men; a little later the same implement drawn by oxen. Here then, we find the beam handle and share, which may be termed nature's contribution to the art of plow-making.

Thus far the plow was a double furrow implement, and the next improvement was to cut off one side of the share so that the dirt would be thrown only one way. Probably the next step was to cover the point with metal, and later on to provide the share with a metal cutting edge.

The mould-board was introduced with the plows of Rome, but it did not accomplish the inversion of the soil. The coulter also, came into use with the Romans; the bridle was first used on the Rotherham plow in 1720; and the proper construction of the mould-board and the extended use of iron was begun at the close of the eighteenth century.

We thus find all the essential parts of the plow initiated by the year 1800, and since that time, the most marked improvements have been to give the plow its great superiority in pulverizing power, lightness of draft, ease of holding, durability, quality of the material, uniformity of wear, regularity of turning the furrow slice and in many other respects. In short, mechanical principles have been better understood and more intelligently applied; simplicity of construction and economy of power have been combined; a better knowledge of the strength of materials has made possible a reduction in the size and clumsiness of the old-style implements. There are now over twelve hundred models of plows constructed, adopted to an almost infinite variety of work and meeting the conditions and requirements of every kind of soil. The further evlution of the plow will probably be continued along the lines of greater depth and a more perfect pulverization, thereby increasing the available fertility and moisture content of the soil.

A Study

OF THE PHYSICAL PROPERTIES OF CLAY AS RELATED TO SOIL STRUCTURE. ABSTRACT OF THESIS BY V. H. DAVIS, JUNE, 1900.

Clay is the second most abundant mineral of the earth's crust, and is found in varying per cents. in almost every soil. Agriculture, however crude or scientific, is dependent more or less on this universal element, and influenced directly or indirectly by the plastic property. But here, as in many other instances, the most indispensable and most common things are known least. The real cause of plasticity is yet a mooted question. It has been proven conclusively, however, that it is a physical and not a chemical property. We must look, therefore, to the physical structure for an answer. The object of this thesis was to determine the relation of plasticity, if any, to the size of the soil particles. Pure clay or kaolinite in a derivate mineral, derived by the decomposition of rock aggregates, chiefly feldspars. Orthoclase is taken as a type of this group with the formulae K_2O, Al_2O_3. $6SiO_2$. This decomposition is brought about by the chemical action of water containing CO_2. The CO_2 combines with the potash,

forming a carbonate of potassium, which is soluble in water. The removal of the potash breaks up the feldspar molecule and we no longer have feldspar but kaolinite, having the formulæ Al 2 O3, 2 Si O2, 3 H2 O.

The term clay seems to be used somewhat indiscriminately. Professor Whitney includes all those small particles remaining suspended in water indefinitely in his "clay group." The word "clay" is a term used for a substance composed essentially of kaolinite. The use of the term clay should not be based on fineness of material alone.

A plastic substance is defined by Prof. Edward Orton, Jr., as one whose shape can be readily changed by a slight expenditure of outside force or gravitation, but whose internal cohesion is sufficient to cause its particles to retain their relative position as soon as outside force ceases to be applied—any substance that can be moulded and will retain its shape. Clay is the only substance having this property in a high degree within itself.

Various ways have been suggested for determining plasticity but none have proven satisfactory. In practice it is usually determined in a direct way, but this is entirely inadequate for the purposes of comparison and the compilation of scientific results. In our investigation we adopted a modified form of the method used by George E. Ladd, Assistant Geologist of Georgia. While the method is not entirely satisfactory it has the advantage of testing the tensile strength of wet clay and thus measuring plasticity directly. The apparatus consists of two rectangular cars with perforated bottoms. Each car is two inches in length and at the closed end, is one and one-half inches wide by one and one-eighth inches deep, inside measure. Near the open end the wall curves inward until the cross section where the car joins is exactly one inch wide and one and one-eighth inches deep. The difference in dimensions between the closed and open ends is to prevent the slipping of the wet clay while testing. The extra depth was intended to allow for shrinkage of the clay when wet by capillarity through the perforations in the bottom, but a few experiments showed that the amount of water taken up by capillarity was either too great or too small to develop the maximum plasticity. The cars are placed on horizontal iron bars. One car is made rigid while the other moves freely, and is connected with a small pan hung over a pulley by means of a fine wire. When ready for use the cars are brought together, clasped firmly and then filled with the substance to be tested. The clasp is then removed and sand added carefully and rapidly to the pan until the column tears apart. The weight of the sand and pan minus the friction previonsly determined, equals the tensile strength of the cube of wet clay. The clay was moulded into the car with the hands as nearly as possible, the same way each time. There is undoubtedly a large "personal equation" to be taken into consideration in studying the results, but no more than in the dry tensile test commonly used. In each case the same sample was tested several times which would tend to eliminate this chance of error to a considerable extent in the averages given in the tables.

To test the power of the various divisions to retain their form after moulding, and also to test the breaking strength of each division when dry, a number of small bricks were made four inches long and one inch square, which, after thoroughly drying, were tested by breaking upon scales arranged to give the force required directly on the beam.

Two substances were used in obtain-

ing the following tables: The first, a ground vitrified paving brick, and the second a moderately plastic clay soil taken upon the University farm. That which is termed the "whole sample" of each, was obtained by sifting through a sieve, twenty meshes to the inch. This "whole sample" was then further separated into the following divisions:

Number of Division.	Size of Particles in M. M.
1	.1 to .75
2	.4 to .25
3	.25 to .15
4	.15 to .05
5	.01 to .005
6	.0025 to .0006

The specific gravity of each "whole sample" was determined in duplicate, and found to be as follows:

Clay	2.695
Ground brick	2.7

Each of the seven divisions were then tested with the apparatus described, and in the manner indicated, with the following results:

TENSILE STRENGTH OF WET SUBSTANCE.

TABLE I.

GROUND BRICK.

Division.	Pct. of Water Added.	Average Tensile Strength per Sq. In. in Grammes.
"Whole Sample"	18.03	182.78
1	18.03	98.65
2	27.05	154.00
3	27.05	153.28
4	27.05	157.05
5	27.05	103.66
6	27.05	109.45

TABLE II.

CAMPUS CLAY.

Division.	Pct. of Water Added.	Average Tensile Strength per Sq. In. in Grammes.
"Whole Sample"	18.03	731.25
1	18.03	67.82
2	18.03	93.08
3	18.03	109.44
4	18.03	176.95
5	25.05	697.72
6	25.05	974.80

The results of the tests of dried bricks described above, are given in the following table:

BREAKING STRENGTH OF DRY SUBSTANCE.

TABLE I.

GROUND BRICK.

Division.	Weight in Grammes Required to Break One Square Inch.
"Whole Sample"	1274
1	Crumbled.
2	Crumbled.
3	Crumbled.
4	Crumbled.
5	1000
6	1450

TABLE II.

CAMPUS CLAY.

Division.	Weight in Grammes Required to Break One Square Inch.
"Whole Sample"	45454.5
1	Crumbled.
2	78.7
3	512.0
4	964.0
5	38636.32
6	34090.87

In the above tests of the dry substances the per cent. of water was not

accurately determined, this factor being eliminated by drying. Table 1 shows that the "whole sample" and divisions five and six retained their form, and required considerable force to break them. The first division slacked on drying, while the second, third and fourth retained their form but crumbled on being moved. From Table 2 it will be seen that division one slacked also, but the breaking strength of the other divisions increased as the particles decreased in size until the fifth division, but decreased for the sixth. This decrease in the first division was probably due to incomplete drying of these bricks.

The most important things to be noticed are as follows: First, Table 1 of the wet test shows that the tensile strength of a wet substance, having no inherent plasticity is practially independent of the size of the particles. Second, Table 2 shows that with a substance naturally plastic, the tensile strength increases as the size of the particles decrease. Third, Table 1 and 2 of the breaking strength of a dry substance show a great difference between the breaking strength of a wet and dry substance, but each method gives the same results relative to each other. We conclude, therefore, that fineness of particles accompanies plasticity and is essential to it, but not in itself a cause of plasticity, and that the real cause is yet to be determined.

How to Improve Ohio Cheese.

We might name a number of things that would improve Ohio cheese, such as the use of the rennet test for determining the acidity of milk for introduction of the rennet, the use of the Wisconsin curd test for detecting and eliminating bad lots of milk, the use of the cheddar process to obtain a uniform and reliable cheese and dwell on these points at length, but we have selected three others that are of prime importance to the industry in Ohio to which we will direct your attention for a short time.

First. Ohio has the reputation of being a skim cheese state. The fat in the milk is the valuable part of it for the quantity increases and the quality of the cheese improves as the fat in the milk increases. About five and a half pounds of cheese can be obtained from one hundred pounds of skim milk. This cheese will be something like a basswood chip in quality and two cents a pound is a good price for it if you can find a fisherman who wants a large piece of fish bait that fish cannot get away with. Two cents a pound for five and a half pounds is eleven cents for your time, fuel, rennet, salt, bandage and box. The skim milk ought to have that much value in it to feed to calves or pigs before spending time and supplies in making such a cheese. If 100 pounds of 4 % fat milk were made into cheese we would have something over ten pounds of a fine quality of cheese that to-day is worth at least twelve cents a pound. The New York market is a little higher than that. That means that we have increased our product four and a half pounds or a little more for the four pounds of fat. We have increased the price about ten cents for the improvement in quality. Eleven cents subtracted from a dollar and twenty cents leaves a dollar and nine cents for the four pounds of fat, or 27.5 cents a pound for it. Unless butter fat will bring more money than that in the form of butter which, by the way, would have to sell at 32 cents, it will pay better to leave it in the cheese. If butter will bring more money than that then it would be a losing bargain to make it into cheese and then all of the fat should be skimmed out and made into butter. If you will look up the market quota-

tions (in the New York Produce Review, for instance) you will find that the prices vary according to the amount of fat left in the cheese. Do not forget that at the same time that the quality is lowered by skimming, the yield from the milk is decreased. We are met by the objection that the extra butter fat in rich milk cannot be worked into cheese. Test your whey with the Babcock test and you will find this statement untrue. Experiments at the Wisconsin and Minnesota experiment stations have shown that the fat can be worked into the cheese more economically from rich than from poor milk. This was true even in cases where the milk was enriched with cream.

Wisconsin full cream has captured the field of Ohio skims in the west and Wisconsin full cream goes through Ohio in car lots to be distributed at Atlanta, Ga. Skims cannot compete with full creams.

We set our stakes then on the proposition that if the price of butter fat is higher when put into cheese all of it should go into the cheese, and if higher for butter all of it should be put into the form of butter. If this proposition is followed Ohio cheese will gain in favor.

We now come to the second part of our subject, the matter of paying for milk according to test. (The speaker here exhibited a photograph of three cheeses each made from 100 pounds of milk, testing 3.3% fat, 4% and 5% fat respectively. The yields were 10.1 lbs., 11.4 lbs., 13.1 lbs.)

Here we have a photograph showing the cheese made from 100 lbs. of each of three different patrons' milk. According to the pooling system, the top of the cheese made from the five per cent. milk would be cut off and put on top of the cheese made from the 3.3% milk to make them average the 4%. If you delivered the five per cent. milk to the factory would you want to have the top of your cheese cut off and given to the man who delivers the poor milk? If you delivered the poor milk would you want the top off from your neighbor's cheese? If you would just remember one of the Ten Commandments says something about coveting what belongs to your neighbor, and if that is not enough there is another that says something about stealing.

The pooling system as practiced in Ohio puts a premium on dishonesty for it encourages watering and skimming, and such a temptation should not be put in the way of an honest farmer. We are not talking without experience in this matter, for about 70 per cent. of the cheddar cheese factories in Wisconsin are paying for milk according to test with such gratifying results that the remainder are falling into line. We in Ohio ought not to let Wisconsin have all of the good things.

Now to the third part of our subject: During the past two years we have tried an experiment and repeated it several times at the Wisconsin Experiment Station of dividing the cheese from a batch of milk and curing the same at different temperatures. We found that cheese cured at forty degrees to fifty degrees ripened slowly, but was of fine texture and quality. At sixty to sixty-five degrees the texture was still fine and the flavor good, but more pronounced. At seventy and above the cheese developed an open texture and rank flavor.

This showed that much cheese that is made well is injured in curing in hot curing rooms. Curing rooms can be kept cool by taking advantage of the cool earth by using well ventilated cellars, or by ventilating well insulated rooms through sub-earth ducts. A sub-earth duct is constructed by digging a trench about twelve feet deep and one hundred feet long or longer. At least

three rows of ten-inch sewer pipe or tile are laid in the trench and then covered over. At each end the tiles open into a well. One of the wells connects with the curing room. Above the other well is erected a tube on top of which is a cowl that always faces the wind. The cowl should be high enough so that the wind is not cut off from it by surrounding objects. The wind is caught by the cowl, is carried down into the ground and passing slowly through the tiles is cooled by the surrounding cool earth and enters the curing room at a temperature of 60° or possibly less. The warm air in the curing room escapes from the top on the opposite from the inlet from the duct.

For reasons which we have not space to explain the moisture in the room is regulated as well as the temperature.

The following points must be observed to make such a curing room successful:

1st. The room must be well insulated with tight double windows and doors.

2nd. For 5,000 cubic feet of space there must be at least three rows of ten-inch tile, one hundred feet long.

3rd. The tile must be at least ten or twelve feet below the surface.

Air may be taken from the bottom of a deep well.

The cost of ducts varies from fifty to two hundred dollars.

About two per cent. is saved on the shrinkage of cheese while the quality is much improved. We are not talking theory about these ducts. A good number are in successful operation in Wisconsin and some of the owners claim that they have repaid the cost the first year.

The Canadian government offers a bonus of fifty dollars to any factory man who will build a duct according to the government's specifications.

If sub-earth ducts are a good thing in Wisconsin and also among our Canadian brethren further north than us, why should we in Ohio linger at the tail end of the procession.

To sum up:

1st. Full cream cheese.

2nd. Paying for milk according to fat test.

3rd. Sub-earth ducts for ventilating curing rooms will greatly improve Ohio cheese.— Professor John W. Decker, in Proceedings of Ohio State Dairymen's Association.

An Inquiry

INTO SOME OF THE CAUSES OF PLANT GROWTH. ABSTRACT OF THESIS BY E. O. FIPPIN, JUNE 1900.

In the growth of corn in pots the proper maturity of the plants does not appear to have been attained, though thoroughly pollenated. The above named investigation was begun to determine what factors requisite for its growth are absent or abnormal under pot conditions. In pursuance of these facts some of the more potent factors of plant growth were varied and united in different combinations.

The soils used were muck, greenhouse compost, first bottom, lake sand, and compost and sand equal parts. To one-half of the forty-eight pots used a complete commercial fertilizer was added. One-half of the pots in the fertilized and unfertilized series received a moderate amount of water during the growth of the corn and to the other half a much larger amount was added. The pots filled with first bottom soil were duplicated in cans having ten times (8 cubic feet) the capacity of the smaller ones to determine the effect of root surface. The temperature, light and heat were uniform for all the pots.

(To be continued.)